Amendments to the Claims

This listing of claims will replace the originally filed claims in the application.

Listing of Claims:

Claims 1 – 26 (cancelled)

Claim 27 (new): A mixed electronic/O^{2-}-anion conductive material of perovskite crystal structure, the electrical neutrality of the crystal lattice of which is preserved characterized in that it consists essentially of a compound of formula (I):

$$A^{(a)}_{(1-x-u)}A'^{(a-l)}_{x}A''^{(a'')}_{u}B^{(b)}_{(l-s-y-v)}B^{(b+l)}_{s}B'^{(b+\beta)}_{y}B''^{(b'')}_{v}O_{3-\delta}, \qquad (I)$$

in which formula (I):

a, a-l, a", b, b+l, b+β and b" are integers representing the respective valences of the atoms A, A', A", B, B' and B"; and a, a", b, b", β, x, y, s, u, v and δ are such that the electrical neutrality of the crystal lattice is preserved;

$a > l$;

a", b and b" are greater than zero;

$-2 \leq \beta \leq 2$;

$a + b = 6$;

$0 < s < x$;

$0 < x \leq 0.5$;

$0 \leq u \leq 0.5$;

$(x + u) \leq 0.5$;

$O \leq y \leq 0.9$;

$0 \leq v \leq 0.9$;

$0 \leq (y + v + s) \leq 0.9$;

$[u(a'' - a) + v(b'' - b) - x + s + \beta y + 2\delta] = 0$;

and $\delta_{min} < \delta < \delta_{max}$ with

$\delta_{min} = [u(a - a'') + v(b - b'') - \beta y]/2$ and

$\delta_{max} = [u(a - a'') + v(b - b'') - \beta y + x]/2$;

and in which formula (I):

A represents an atom chosen from scandium, yttrium or from the families of lanthanides, actinides or alkaline-earth metals;

A', which differs from A, represents an atom chosen from scandium, yttrium or from the families of lanthanides, actinides or alkaline-earth metals;

A", which is different from A and A', represents an atom chosen from aluminum (Al), gallium (Ga), indium (In) and thallium (Tl);

B represents an atom chosen from the transition metals that can exist in several possible valences;

B', which differs from B, represents an atom chosen from transition metals, aluminum (Al), indium (In), gallium (Ga), germanium (Ge), antimony (Sb), bismuth (Bi), tin (Sn) and lead (Pb); and

B", which differs from B and B', represents an atom chosen from transition metals, metals of the alkaline-earth family, aluminum (Al), indium (In), gallium (Ga), germanium (Ge), antimony (Sb), bismuth (Bi), tin (Sn) and lead (Pb).

Claim 28 (new): The material as defined in claim 27, for which, in formula (I), δ is equal to an optimum value δ_{opt} that allows it to ensure an optimum ionic conductivity for sufficient stability under operating temperature and pressure conditions as a mixed ionic/electronic conductor.

Claim 29 (new): The material as defined in claim 27, for which, in formula (I), a and b are equal to 3.

Claim 30 (new): The material as defined in claim 27, in which, in formula (I), u is equal to zero.

Claim 31 (new): The material as defined in claim 27, in which, in formula (I), u is different from zero.

Claim 32 (new): The material as defined in claim 27, for which, in formula (I), the sum (y + v) is equal to zero.

Claim 33 (new): The material as defined in claim 27, for which, in formula (I), the sum (y + v) is different from zero.

Claim 34 (new): The material as defined claim 27, for which, in formula (I), A is chosen from La, Ce, Y, Gd, Mg, Ca, Sr or Ba.

Claim 35 (new): The material as defined in claim 34, of formula (Ia):

$$La^{(III)}_{(1-x-u)}A'^{(II)}_{x}A''^{(a'')}_{u}B^{(III)}_{(1-s-y-v)}B^{(IV)}_{s}B'^{(3+\beta)}_{y}B''^{(b'')}_{v}O_{3-\delta} \qquad \text{Ia),}$$

corresponding to formula (I) in which a and b are equal to 3 and A represents lanthanum.

Claim 36 (new): The material as defined in claim 27, for which, in formula (I), A' is chosen from La, Ce, Y, Gd, Mg, Ca, Sr or Ba.

Claim 37 (new): The material as defined in claim 36, of formula (Ib):

$$A^{(III)}_{(1-x-u)}Sr^{(II)}_{x}A''^{(a'')}_{u}B^{(III)}_{(1-s-y-v)}B^{(IV)}_{s}B'^{(3+\beta)}_{y}B''^{(b'')}_{v}O_{3-\delta} \qquad \text{(Ib)},$$

corresponding to formula (I) in which a and b are equal to 3 and A' represents strontium.

Claim 38 (new): The material as defined in claim 27, for which, in formula (I), B is chosen from Fe, Cr, Mn, Co, Ni and Ti.

Claim 39 (new): The material as defined in claim 12, of formula (Ic):

$$A^{(III)}_{(1-x-u)}A'^{(II)}_{x}A''^{(a'')}_{u}Fe^{(III)}_{(1-s-y-v)}Fe^{(IV)}_{s}B'^{(3+\beta)}_{y}B''^{(b'')}_{v}O_{3-\delta} \qquad \text{(Ic)},$$

corresponding to formula (I) in which b = 3 and B represents an iron atom.

Claim 40 (new): The material as defined in claim 27, for which, in formula (I), B' is chosen from Co, Ni, Ti and Ga.

Claim 41 (new): The material as defined in claim 27, for which, in formula (I), B" is chosen from Ti or Ga.

Claim 42 (new): The material as defined in claim 41, of formula (Id),

$$La^{(III)}_{(1-x)}Sr^{(II)}_{x}Fe^{(III)}_{(1-s-v)}Fe^{(IV)}_{s}B''^{(b'')}_{v}O_{3-\delta} \qquad \text{(Id)},$$

corresponding to formula (I) in which a = b = 3, u = 0, y = 0, B represents an iron atom, A is a lanthanum atom and A' is a strontium atom.

Claim 43 (new): The material as defined in claim 27, for which, in formula (I), A" is chosen from Ba, Al and Ga.

Claim 44 (new): The material as defined in claim 27, for which formula (I) is either:

$La^{(III)}_{(1-x-u)}\ Sr^{(II)}_{x}\ Al^{(III)}_{u}\ Fe^{(III)}_{(1-s-v)}\ Fe^{(IV)}_{s}\ Ti_{v}\ O_{3-\delta}$,

$La^{(III)}_{(1-x-u)}\ Sr^{(II)}_{x}\ Al^{(III)}_{u}\ Fe^{(III)}_{(1-s-v)}\ Fe^{(IV)}_{s}\ Ga_{v}\ O_{3-\delta}$,

$La^{(III)}_{(1-x)}\ Sr^{(II)}_{x}\ Fe^{(III)}_{(1-s-v)}\ Fe^{(IV)}_{s}\ Ti_{v}\ O_{3-\delta}$,

$La^{(III)}_{(1-x)}\ Sr^{(II)}_{x}\ Fe^{(III)}_{(1-s-v)}\ Fe^{(IV)}_{s}\ Ga_{v}\ O_{3-\delta}$ or

$La^{(III)}_{(1-x)}\ Sr^{(II)}_{x}\ Fe^{(III)}_{(1-s)}\ Fe^{(IV)}_{s}\ O_{3-\delta}$.

Claim 45 (new): The material of formula (Id) as defined in claim 42, in which x is equal to 0.4, B" represents a trivalent gallium atom, v is equal to 0.1 and $\delta = 0.2 - (s/2)$ and δ is preferably equal to $\delta_{opt} = 0.180 \pm 0.018$.

Claim 46 (new): A method of preparing a mixed electronic/O^{2-} anion conductive material of perovskite crystal structure, the electrical neutrality of the crystal lattice of which is preserved, represented by the crude formula (I'):

$$A_{(1-x-u)}A'_xA"_uB_{(1-y-v)}B'_yB"_vO_{3-\delta}, \qquad (I')$$

in which formula (I'):

x, y, u, v and δ are such that the electrical neutrality of the crystal lattice is preserved;

$0 < x \leq 0.5$;

$0 \leq u \leq 0.5$;

$(x + u) \leq 0.5$;

$0 \leq y \leq 0.9$;

$0 \leq v \leq 0.9$;

$0 \leq (y + v) \leq 0.9$; and

$0 < \delta$

and in which formula (I'):

A represents an atom chosen from scandium, yttrium or from the families of lanthanides, actinides or alkaline-earth metals;

A', which differs from A, represents an atom chosen from scandium, yttrium or from the families of lanthanides, actinides or alkaline-earth metals;

A", which is different from A and A', represents an atom chosen from aluminum (Al), gallium 9Ga), indium (In) and thallium (Tl);

B represents an atom chosen from the transition metals that can exist in several possible valences;

B', which differs from B, represents an atom chosen from transition metals, aluminum (Al), indium (In), gallium (Ga), germanium (Ge), antimony (Sb), bismuth (Bi), tin (Sn) and lead (Pb); and

B", which differs from B and B', represents an atom chosen from transition metals, metals of the alkaline-earth family, aluminum (Al), indium (In), gallium (Ga), germanium (Ge), antimony (Sb), bismuth (Bi), tin (Sn) and lead (Pb);

characterized in that it comprises the following successive steps:

- a step (a) of synthesizing a powder having an essentially perovskite crystal phase from a blend of compounds consisting of at least one carbonate and/or of an oxide

and/or of a sulfate and/or of a nitrate and/or of a salt of each of the elements A, A' and B and, if necessary, of a carbonate and/or of an oxide of A", B' and/or B";

- a step (b) of forming the powder blend obtained from step (a);
- a step (c) of removing the binder from the formed material obtained from step (b); and
- a step (d) of sintering the material obtained from step (c);

and characterized in that at least one of steps (a), (c) and (d) is carried out while controlling the oxygen partial pressure (pO_2) of the gaseous atmosphere surrounding the reaction mixture.

Claim 47 (new): The method as defined in claim 46, characterized in that step (c) is carried out while controlling the oxygen partial pressure (pO_2) of the gaseous atmosphere surrounding the material from which the binder is to be removed.

Claim 48 (new): The method as defined in claim 46, in which step (d) is carried out in a gaseous atmosphere having an oxygen partial pressure not exceeding 0.1 Pa.

Claim 49 (new): The method as defined in claim 48, in which step (a) is carried out in air.

Claim 50 (new): A mixed electronic/O^{2-} anion conductive material of perovskite crystal structure, the electrical neutrality of the crystal lattice of which is preserved, represented by the crude formula (I'):

$$A_{(1-x-u)}A'_xA''_uB_{(1-y-v)}B'_yB''_vO_{3-\delta}, \qquad (I')$$

in which formula (I'):

x, y, u, v and δ are such that the electrical neutrality of the crystal lattice is preserved;

$0 < x \leq 0.5$;

$0 \leq u \leq 0.5$;

$(x + u) \leq 0.5$;

$0 \leq y \leq 0.9$;

$0 \leq v \leq 0.9$;

$0 \leq (y + v) \leq 0.9$; and

$0 < \delta$

and in which formula (I'):

A represents an atom chosen from scandium, yttrium or from the families of lanthanides,

actinides or alkaline-earth metals;

A', which differs from A, represents an atom chosen from scandium, yttrium or from the families of lanthanides, actinides or alkaline-earth metals;

A", which is different from A and A', represents an atom chosen from aluminum (Al), gallium (Ga), indium (In) and thallium (Tl);

B represents an atom chosen from the transition metals that can exist in several possible valences;

B', which differs from B, represents an atom chosen from transition metals, aluminum (Al), indium (In), gallium (Ga), germanium (Ge), antimony (Sb), bismuth (Bi), tin (Sn) and lead (Pb); and

B", which differs from B and B', represents an atom chosen from transition metals, metals of the alkaline-earth family, aluminum (Al), indium (In), gallium (Ga), germanium (Ge), antimony (Sb), bismuth (Bi), tin (Sn) and lead (Pb);

and in which δ depends on the oxygen partial pressure in the gaseous atmospheres in which steps (a), (d) and optionally (c) of the method as defined in one of claims 20 to 23 take place.

Claim 51 (new): Use of the material as defined in claim 27 as mixed conductive material of a catalytic membrane reactor designed to be used to synthesize syngas by the oxidation of methane or natural gas.

Claim 52 (new): Use of the material as defined in claim 27 as mixed conductive material of a ceramic membrane designed to be used to separate oxygen from air.